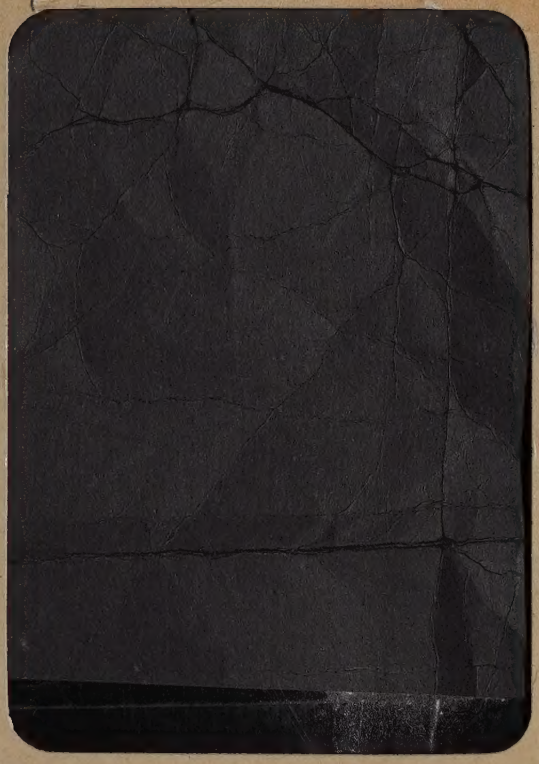
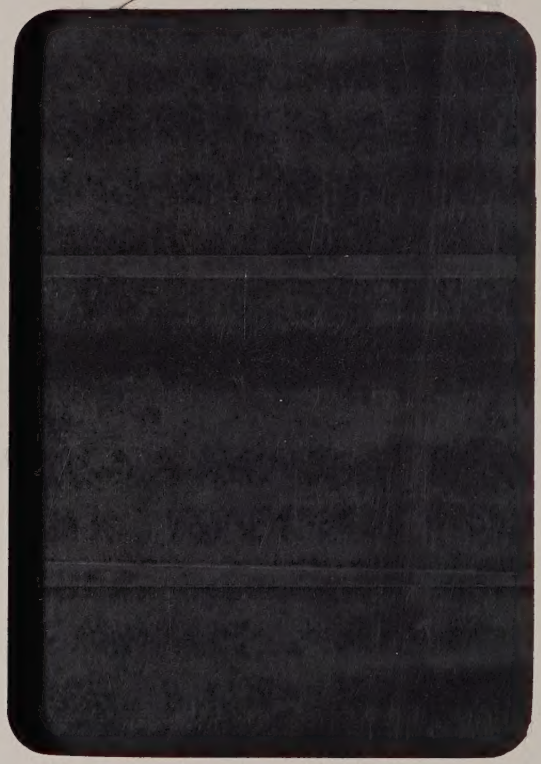


INSTRUCTION MANUAL

SMITHS INDUSTRIAL DIVISION



SERVICING FACILITIES

Servicing of equipment and maintenance of installations to be carried out by Smiths personnel are directed from the Service Departments. Requests for service of this nature should be addressed to the relevant department as shown below.

1. **Routine Servicing**

1.1. For equipment located in WALES or ENGLAND (except NORTHUMBERLAND, CUMBERLAND, COUNTY DURHAM and the NORTH RIDING OF YORKSHIRE) kindly address requests to:

Smiths Industrial Division
Industrial Service Department
New North Road
Barkingside, Essex
Telephone: Hainault 2601
Telegrams: Husun, Barkingside
Telex: 25368

1.2. For equipment located in SCOTLAND, NORTHERN IRELAND, NORTHUMBERLAND, CUMBERLAND, COUNTY DURHAM or the NORTH RIDING OF YORKSHIRE kindly address requests to:

Smiths Industrial Division
60/72 Kelvin Avenue
Hillington
Glasgow, S.W.2
Telephone: Halfway 3331
Telegrams: Meter, Glasgow
Telex: 77535

1.3. For equipment located in ANY COUNTRY OVERSEAS - please *write* to:

Smiths Industrial Division
Kelvin House
Wembley Park Drive
Wembley, Middlesex
Telephone: Wembley 8888
Telegrams: Kelhue, Wembley
Telex: 25366

2. **Major Servicing**

2.1. Kindly write, giving full details of the defect encountered or service required, to the relevant area address as given for routine servicing.

2.2. If it is necessary to return an instrument or accessory to Kelvin Hughes it should be despatched to the relevant address and accompanied by a copy of the letter referred to in para. 2.1.

THIS SPECIFICATION IS APPROVED
FOR USE IN THE CALIBRATION OF
COMPANY INSTRUMENTS.
5
QC FACILITIES
CALIBRATION DEPARTMENT
DATE: 25-1-80
BRITISH AIRCRAFT CORPORATION, STEVENAGE.

High Speed Pen Recorder Single Channel Mark 5

Publication No. SID/T506/R4
(formerly IND 606)

Servicing Facilities : See inside front cover

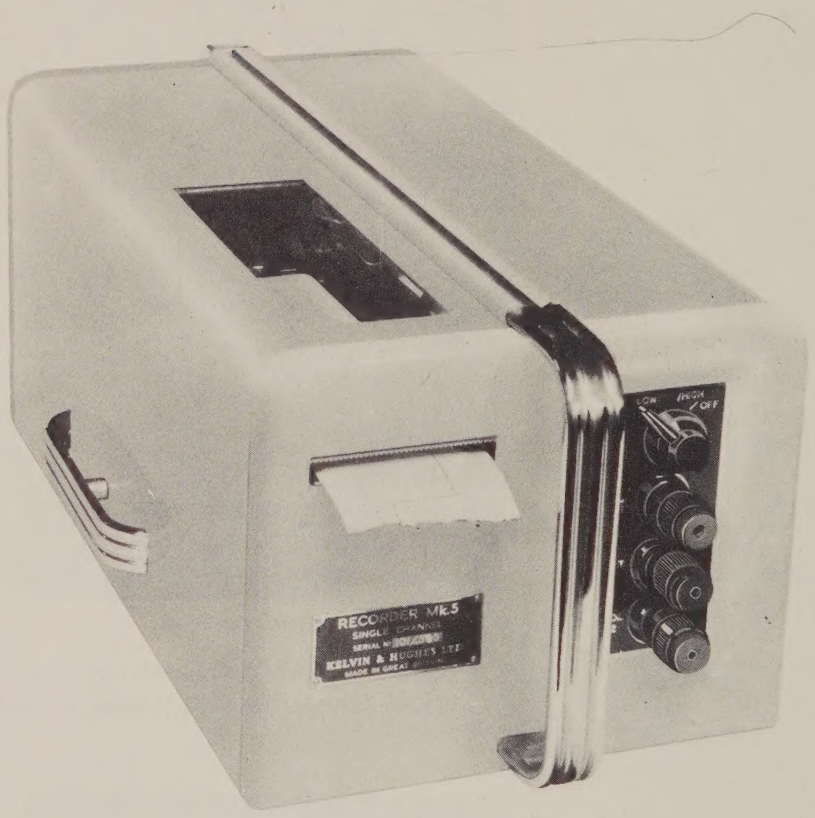
Amendments : See inside rear cover

Important : Please read this manual in conjunction with any amendments which may be bound in at the back

SMITHS INDUSTRIAL DIVISION

The Industrial Division of **S. Smith & Sons (England) Ltd**

Kelvin House, Wembley Park Drive, Wembley, Middx. Wembley 8888



HIGH SPEED PEN RECORDER MARK 5

High Speed Pen Recorder
Single Channel Mk. 5

INDEX

SECTION 1 - Description.
1. General.
2. Magnet and Coil Unit.
3. Motor, gearbox and paper drive.
4. Electrical Unit.
5. Mains supply
6. Recording Paper

SECTION 2 - Operation.
1. General.
2. Replacing recording paper.
3. Paper speed selection.

SECTION 3 - Application.
1. Time interval error.
2. Drive Amplifier.
3. Carrier Amplifier.

SECTION 4. - Maintenance.
1. Stylii.
2. Stylus replacement.
3. Coil Unit replacement.
4. Coil Unit repair service.
5. Lubrication.
6. Spares.

APPENDIX 1 - Coil Units - standard pattern.

Illustrations

FIG. 1 - High speed pen recorder Mk. 5.
FIG. 2 - Overall dimensions and general view.
FIG. 3 - Paper speed change gears.
FIG. 4 - Coil Unit.
FIG. 5 - Circuit diagram.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_11354

SECTION 1

DESCRIPTION

1. GENERAL.

1.1. Kelvin Hughes Single Channel Recorder Mark 5 is a mains driven instrument for recording phenomenon which can be converted into an electrical signal. It is particularly suitable for phenomena having a comparatively high rate of change.

1.2. Essentially, the instrument consists of a magnet, carrying between its poles a stiffly suspended moving coil unit to which is attached a stylus. A paper drive system, using a motor and reduction gearing, draws the dry recording paper under the stylus point, and a current passing through the paper causes a permanent black line to be drawn.

1.3. Recorders operate from any A.C. supply of 50 or 60 c/s, 100/120V or 200/250V.

1.4. Overall dimensions and weight of the recorder are:

Width:	8 ins.	(20.30 cm)
Height:	$6\frac{1}{2}$ ins.	(15.90 cm)
Depth:	$14\frac{1}{2}$ ins.	(36.80 cm)
Weight:	18 lbs.	(8.15 kg.)

2. MAGNET AND COIL UNIT.

2.1. This assembly has been designed to operate as a damped system when connected to a source of supply of a given impedance. It will respond uniformly to all frequencies up to at least 60 c/s with the minimum driving power. A system of low inertia and acute stiffness minimises the effect of pen friction. Details of all standard pattern coil units are given in Appendix 1. Only those having a pen radius of 9.2 cms can be fitted to this recorder.

2.2. FIG 4 shows a coil unit removed from the magnet poles. The moving coil (A) is wound on an aluminium former to provide the desired amount of internal damping. A suspension strip (B) passes axially through the coil and a soft iron core (F), carries the pen saddle (C), and is held in tension by adjusting screws and nuts (D and E). Tension is adjusted to provide the desired stiffness. Guides (G) enable the unit to be lowered into the magnet poles without damaging the coil.

2.3. The stylii (H) are pivoted into the saddle by means of a spring fork (K). Spring (L) provides the required pressure of the point (J), on the paper. The stylus is of tubular construction and has an iridium-platinum point.

2.4. Connections to the ends of the coil are brought to tags (M) and (N), and the centre-tap is connected to tag (P). Tag (O) carries the high-tension marking supply to the stylus

3. MOTOR, GEARBOX AND PAPER DRIVE.

3.1. The motor is a Kelvin Hughes M.25 Mk.I 3-phase machine running synchronously at 3000 r.p.m. on 50 c/s supply. The single-phase supply is phase-split by means of a O.75 μF condenser. Consumption is approximately 15 watts at 230 v.

3.2. Gearing is interposed between the motor and driving wheel, to drive the paper at the required speed. Operation of the switch on the front panel reverses the direction of the motor, actuates a double rachet system, and introduces a new train of gears. Thus, two paper speeds in the ratio of 1 : 4 are available at will.

3.3. Any one of three pairs of speeds may be obtained by interchanging the gears in the left hand gearbox (FIG. 2b - A) as described in paragraph 3 of Operation Instructions. Paper speeds obtainable are:

For 50 c/s supply:	O.25	and 1 cm/sec.
	O.5	and 2 cm/sec.
	2.5	and 10 cm/sec.
For 60 c/s supply:	O.3	and 1.2 cm/sec.
	O.6	and 2.4 cm/sec.
	3.O	and 12.O cm/sec.

3.4. Accuracy of these speeds is within 1% of the stated value when the mains frequency is accurate.

3.5. The spool carrying the paper supply is friction-loaded to prevent over-running.

4. ELECTRICAL UNIT.

4.1. Located in the recorder, at the right, this unit contains a mains transformer, a metal rectifier, and smoothing condenser for providing the D.C. marking supply, and a phase splitting condenser for the motor. (See Circuit Diagram).

5. MAINS SUPPLY.

5.1. The mains input socket and the two input fuses are located at the rear of the recorder.

6. RECORDING PAPER.

6.1. The Recording paper depends for its action on the dry electrolytic reduction of chemical compounds in the top (grey) layer of the paper.

6.2. Paper for these recorders is supplied in rolls 150 ft. long, 55 mm. wide, plain or printed with millimetre longitudinal lines, and millimetre transverse arcs. The various papers available are listed in paragraph 6 of Maintenance Section.

SECTION 2

OPERATION

1. GENERAL.

1.1. Verify that the mains voltage selector plug, situated on the transformer in the electrical unit is in the tapping appropriate to the supply available.

1.2. With the cable supplied, connect the instrument to the A.C. mains. Connections to the source of signals to be recorded should be made to the three terminals on the front panel, the middle one being the centre tap of the coil, interposing any amplifier which may be required.

1.3. The mains switch has two 'on' positions, marked 'High' and 'Low' respectively. Rotation of this switch to either position starts the paper drive at a speed appropriate to the position chosen and applies the marking voltage to the pen.

1.4. On changing the switch from 'High' to 'Low' or vice versa, approximately 15 seconds may elapse before the paper begins to move. This is unavoidable with this type of gear changing mechanism as the driving rachet in the gear box requires this time to take up the drive.

2. REPLACING RECORDING PAPER.

2.1. To insert a roll of paper (Refer to FIG. 2b).

(i) By means of lever (C) raise stylus to the position shown.
(ii) Remove spool flange (D) and withdraw empty former.
(iii) Place new roll of paper on the spool centre, pressing the former well home against the far flange of the spool.
(iv) Thread end of paper over the guide (E), pass it between the milled driving wheel and the pressure roller while depressing the serrated end of the roller housing (F), and allow the paper to pass through the slot in the front panel.
(v) Replace spool flange, and lower stylus.

3. PAPER SPEED SELECTION.

3.1. To change from one pair of paper speeds to another, remove the left-hand gearbox cover (FIG. 2b - A) by means of its four screws and withdraw the two wheels engraved 'D' and 'G', (FIG. 3) together with the two small spacers. Should the wheels be difficult to remove with the fingers, the stylus tweezers may be sprung into the wheel holes.

3.2. Replace wheels and spacers in the following order:

For 0.25 and 1 cm/sec. (FIG. 3a)
(i) Wheel 'D' on upper spindle.
(ii) Spacer on lower spindle.

(iii) Wheel 'G' on lower spindle.
(iv) Spacer on upper spindle.

For 0.5 and 2 cm/sec. (FIG. 3b).
(i) Wheel 'G' on Upper spindle.
(ii) Spacer on lower spindle.
(iii) Wheel 'D' on lower spindle.
(iv) Spacer on upper spindle.

For 2.5 and 10 cm/sec. (FIG. 3c).
(i) Wheel 'G' on lower spindle.
(ii) Spacer on upper spindle.
(iii) Wheel 'D' on upper spindle.
(iv) Spacer on lower spindle.

3.3. Replace gearbox cover and secure with the four screws.

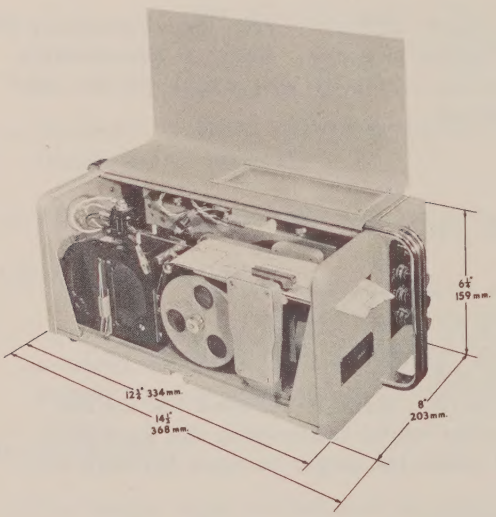


FIG. 2a

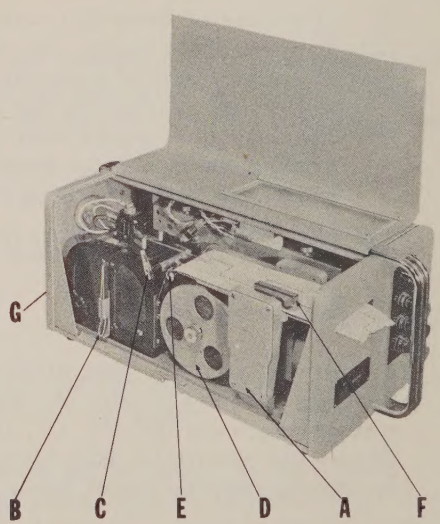


FIG. 2b

FIG. 2 - OVERALL DEMENSIONS AND GENERAL VIEW

SECTION 3

APPLICATION

1. TIME INTERVAL ERROR.

1.1. When a high degree of accuracy is required, account must be taken of the time interval measurement error due to the transverse curvature of the trace. This can be overcome by the use of the special paper printed with transverse arcs at the pen radius.

2. DRIVE AMPLIFIER.

2.1. Generally, it will be necessary to employ amplifiers to feed the 4500 ohms resistance coils, because:

(i) often the required power is not available from the source of signal, or the impedance of the coil causes too much disturbance in the circuit under test.

and

(ii) as damping depends on the external circuit this generally can only be kept constant by use of a correctly designed amplifier.

2.2. All information on the coil units, for correct coupling into amplifier circuits, is given in Appendix 1.

2.3. A range of Kelving Hughes Drive Amplifiers and Pre-Amplifiers is available for 4500 ohms resistance coil units.

3. CARRIER AMPLIFIERS.

3.1. When it is desired to record any phenomena which can be converted into an impedance change i.e. Resistance (Strain Gauges), Inductance (Accelerometer and Displacement Pick Up) and Capacity (Pressure and Displacement) a carrier amplifier can be used. Kelvin Hughes has developed amplifiers for this purpose.

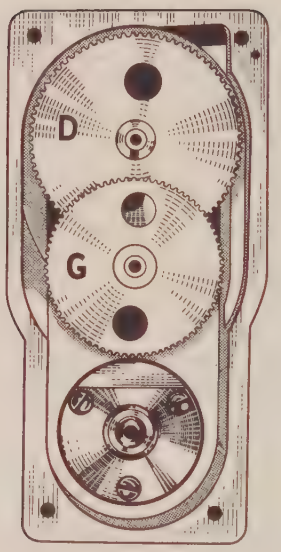


FIG. 3a

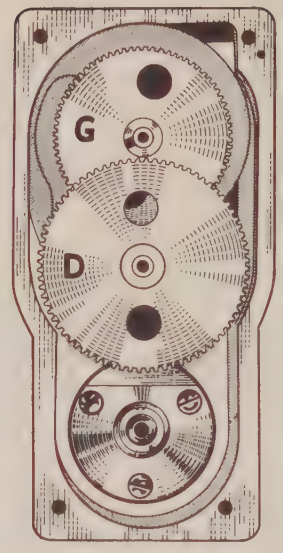


FIG. 3b

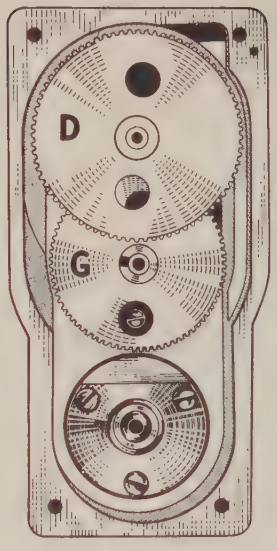


FIG. 3c

FIG. 3 - PAPER SPEED CHANGE GEARS

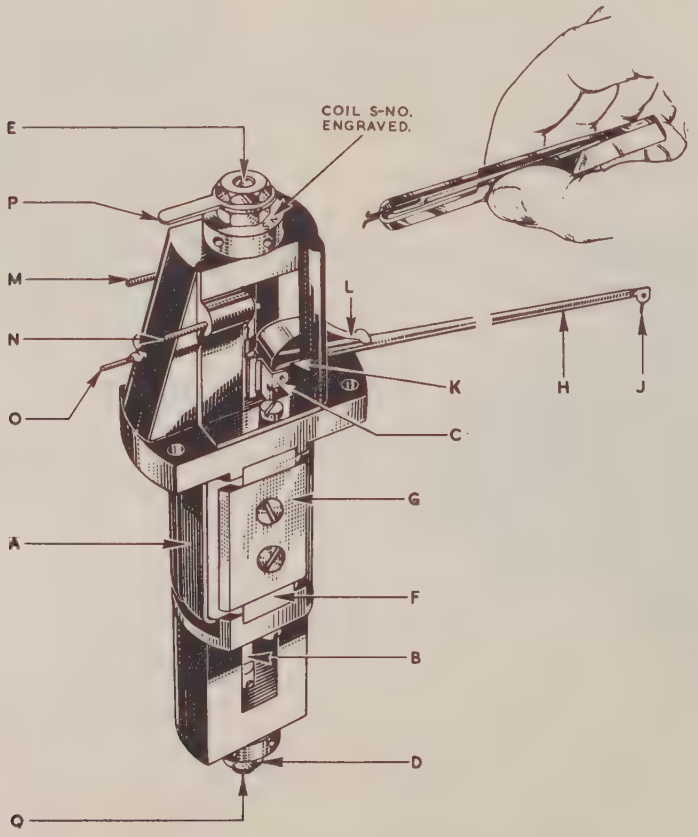


FIG. 4 - COIL UNIT

SECTION 4

MAINTENANCE

1. STYLII.

1.1. During recording, there is a tendency for carbon to deposit on the stylus tip, causing deterioration in the clarity of the marking. This deposit may readily be removed with tweezers or any small pointed instrument.
AS THE STYLUS IS OPERATED AT 500 VOLTS, CARE SHOULD BE TAKEN TO SWITCH OFF BEFORE HANDLING IT.

1.2. The iridium-platinum alloy stylus tip has an extremely low rate of erosion. The recorder should not be run without paper for this causes burning of the platen.

1.3. The stylus to paper pressure as measured at the tip is set to about 0.3 gram. Unless mechanical damage is sustained, this pressure should not need re-adjustment. Normally, in the event of mechanical damage, replacement of the affected part is recommended.

1.4. The spring (FIG. 4-L) is retained in the saddle by means of an adhesive such as 'Durofix'.

1.5. Zero adjustment is made by the screw (E) without slackening its lock-nut.

2. STYLUS REPLACEMENT.

2.1. Special tweezers(FIG. 2b-B and FIG.4) are supplied for removal and replacement of the pen. No attempt should be made to remove the pen spring for this operation.

3. COIL UNIT REPLACEMENT.

3.1. Place the keepers provided in the pole piece gaps on either side of the coil unit.
IMPORTANT: DO NOT WITHDRAW THE COIL UNIT FROM THE MAGNET, WITHOUT THE USE OF KEEPERS. TO DO SO WOULD RESULT IN PARTIAL DEMAGNETISATION AND A REDUCTION IN DAMPING.

3.2. Remove leads from the rear and top of the coil unit.

3.3. Remove fixing screws at each corner of the flange.

3.4. Remove coil unit by holding it firmly by its sides and pulling vertically.

3.5. Fit new coil unit. It is important to hold the coil firmly and lower gently, as it will be draw in by the magnet.

3.6. Replace screws and leads.

3.7. Remove keepers.

3.8. Check stylus pressure. (See Maintenance Section para. 1.3.).

3.9. The coil former is fragile. It should be handled very carefully as its dimensions are of great importance.

4. COIL UNIT REPAIR SERVICE.

4.1. Smiths Industrial Division operate a repair service for all coil units, and coils for repair should be forwarded, together with relevant details, to our Service Department.

5. LUBRICATION.

5.1. Lubrication of any bearings in the instrument is not normally required. However, after a very long period of use, a small quantity of light oil may be applied to the gearbox bearings and driving roller. Do not apply oil to motor bearings, the motor worm or worm-wheel, or to the pressure-roller bearing. Light grease may be used on gears 'D' and 'G'.

6. SPARES.

6.1. Paper.

Electrosensitive plain.	Z 77.280
Electrosensitive printed mm. squares	Z 77.281
Electrosensitive printed mm. longitudinal lines and mm. transverse arcs.	Z 77.282

6.3. Miscellaneous.

Lamp 6.3.v. 3W.	ZV. 1785
Fuse 500 ma	ZV. 497

Appendix 1.

Coil Units-Standard Pattern

DESCRIPTION

These coil units consist basically of a stiffly suspended moving galvanometer unit with a stylus arm attached. Eddy currents in the metal former and the coil, the latter due to the presence of the external circuit, provide the requisite amount of damping. Natural frequency of the system is adjusted by variation of tension in the suspension. A Spring is provided to adjust pen to paper pressure.

Specifications of some standard coil units, available for fitting to KELVIN HUGHES High Speed Pen Recorders, are given in a table overleaf. Should none of these appear suitable for a particular application, recommendations will be made upon receipt of the following details:-

D.C. Resistance
Pen Radius or Type of Recorder
External Circuit Resistance
Sensitivity
Uniform Frequency Limit

TYPE

Standard pattern Coil Units have a prefix code 'S' which should always be quoted.

D C. RESISTANCE

Coils are 4 ohms, 450 ohms or 4500 ohms, the latter two being centre tapped for push-pull operation Low resistance coils are used mainly for current measurement with low resistance shunts or for transformer coupling when D.C. level is not required.

EXTERNAL RESISTANCE

The coil unit must be operated with an external circuit resistance of approximately that for which the coil was designed.

e.g. S.9 0-1 K ohms external resistance - for connection in cathode circuit of valve amplifier.
S13. 5-7 K ohms external resistance - for connection in anode circuit of valve amplifier

PHASE RESPONSE

Phase shift is substantially proportional to frequency within the range of uniform frequency response. Transient wave-forms containing only components within this range are therefore correctly reproduced.

OPERATING CONDITIONS

After a period of time, owing to the possible presence of metal particles in the magnet gap, it is not safe to apply more than 50 volts between the coil centre-tap and magnet, i.e. 100V. between coil centre-taps in a multi-channel recorder. However, the magnet is insulated from the instrument frame and voltages up to500V. may be applied between coil centre tap and earth.

FULL SCALE DEFLECTION

When fitted with a 6.05 cms stylus, coil units are capable of a F.S.D. of ±1.2 cms, but when fitted to a multi-channel recorder, deflection is limited, by proximity, to ± .75 cms.

When fitted with a 9.2 cms stylus maximum deflection is ± 2 cms, and when fitted to a multi-channel recorder, deflection is limited, by proximity, to ± 1.65 cms.

FREQUENCY RESPONSE

Response is such that sensitivity does not differ, by more than the tolerance given (see Table) from the D.C. value from 0 c/s to the limiting frequency.

RISE TIME

With more sensitive coils, rise time is given instead of frequency response. Rise time is time taken for the stylus to reach full deflection.

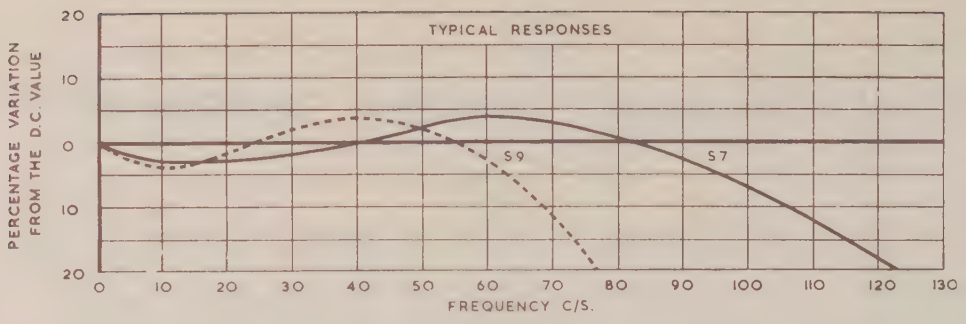
DAMPING

When operated from a circuit of correct internal resistance (see Table), damping is such that a maximum overswing between 5 and 10% for different coils results from the instantaneous application of a deflecting voltage.

LINEARITY

Deflections obtained for a third of the current or voltage required for full scale deflection should not exceed a third of F.S.D. by more than the percentages given in the Table.

These linearity figures include errors caused by transverse curvature of the trace, and friction between stylus and moving paper creating returning torque. Under the worst conditions, these errors will not exceed 1%.



Type No.	Res. D.C. Ohms	Radius Pen cms	Def. Max. cms	Ext. Cir. Res. Ohms	D.C. Sensitivity (±20%) V/FSD	D.C. Sensitivity (±20%) mA/FSD	Freq. Res Limit c/s	Tol. %	Freq. 3 db down	Rise Time Secs	Damp %	Linearity Volts %	Linearity Current %
S16	4	6.05	.75 1.2	Nil	1.5 2.4	375 600	—	—	—	.05	—	3 5	3 3
S3	4	6.05	.75 1.2	Nil	2.5 4	625 1,000	75	6	150	—	7	4 8	3 5
S1	4	6.05	.75 1.2	5	1.7 2.7	425 680	65	6	—	—	7	4 8	3 5
S29	4	9.2	1.65 2.0	Nil	2.4 2.9	585 710	50	10	70	—	10	7	5
S59	450	6.05	.75 1.2	Nil	22 35	50 80	90	10	150	—	7	4 8	3 5
S54	450	9.2	1.65 2.0	Nil	5.8 7	13.5 16	—	—	—	.1	—	3	3
S58	450	9.2	1.65 2.0	Nil	10.5 12.5	23 27	—	—	—	.1	—	5	3
S56	4.5K	6.05	.75 1.2	Nil	30 48	6.7 11	—	—		.02	—	3	3
S14	4.5K	6.05	.75 1.2	12K	42 68	9.5 15.0	80	10	100	—	7	4 8	3 5
S5	4.5K	6.05	.75 1.2	5-7K	45 72	10 16	80	6	120	—	7	4 8	3 5
S7	4.5K	6.05	.75 1.2	0-1K	70 110	15.5 24.5	90	6	150	—	7	4 8	3 5
S12	4.5K	9.2	1.65 2.0	Nil	19 22.5	4.15 5	—	—	—	.2	—	3	3
S43	4.5K	9.2	1.65 2.0	0-1K	41.5 50	9 11	—	—	—	.02	—	5	3
S21	4.5K	9.2	1.65 2.0	1.5K	75 90	16.5 20	50	6	90	—	10	7	5
S13	4.5K	9.2	1.65 2.0	5-7K	60 72	13.5 16	50	6	80	—	10	7	5
S9	4.5K	9.2	1.65 2.0	0-1K	83 100	19 22.5	60	6	100	—	10	8	3

SIDE ZERO

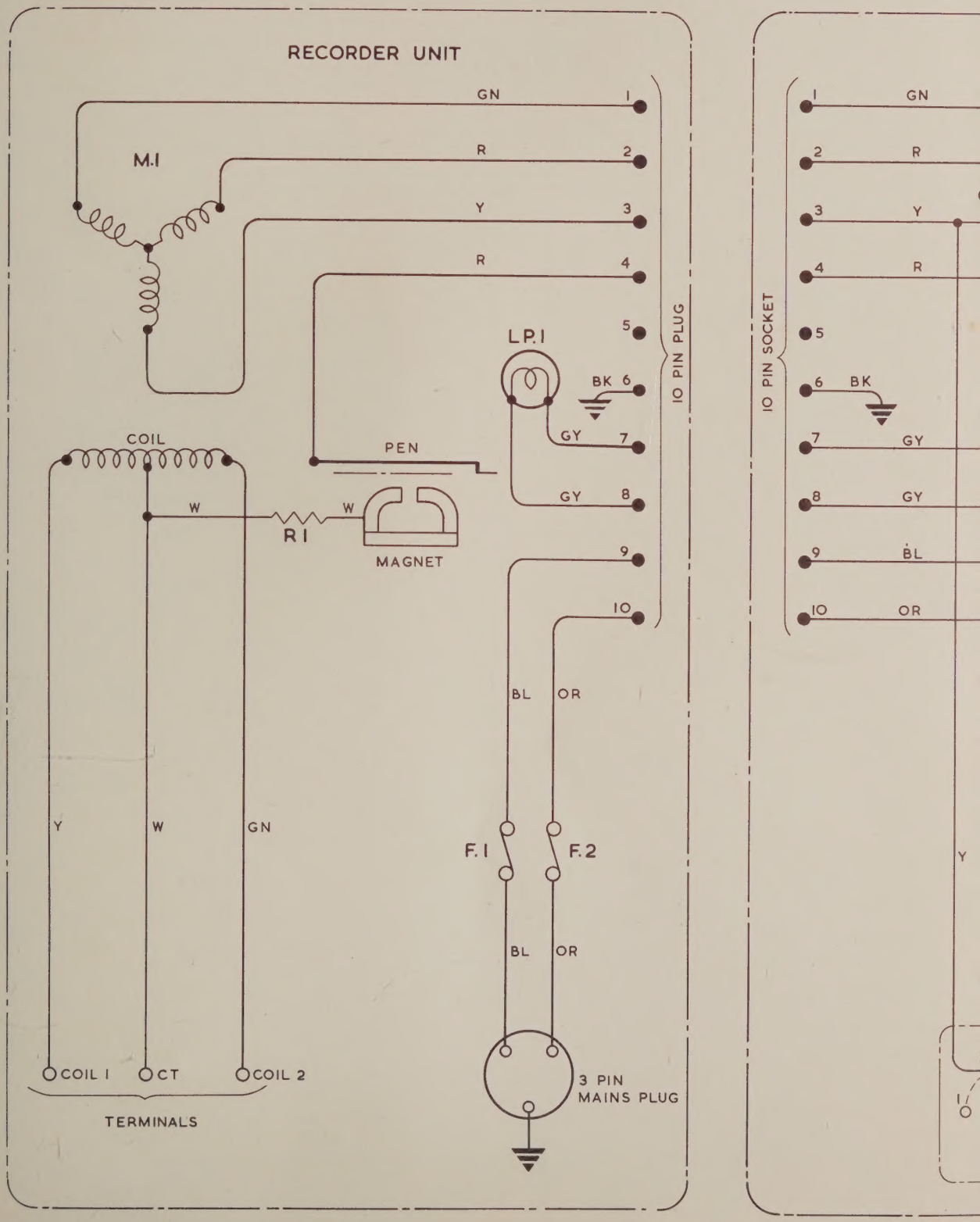
If side zero recording is desired with the low sensitivity coils it is preferable to offset the stylus by electrical means using an amplifier, thereby keeping the power dissipation within the limits of the coil. With the more sensitive coils it is possible to offset the coil mechanically and use the maximum deflection.

POWER DISSIPATION

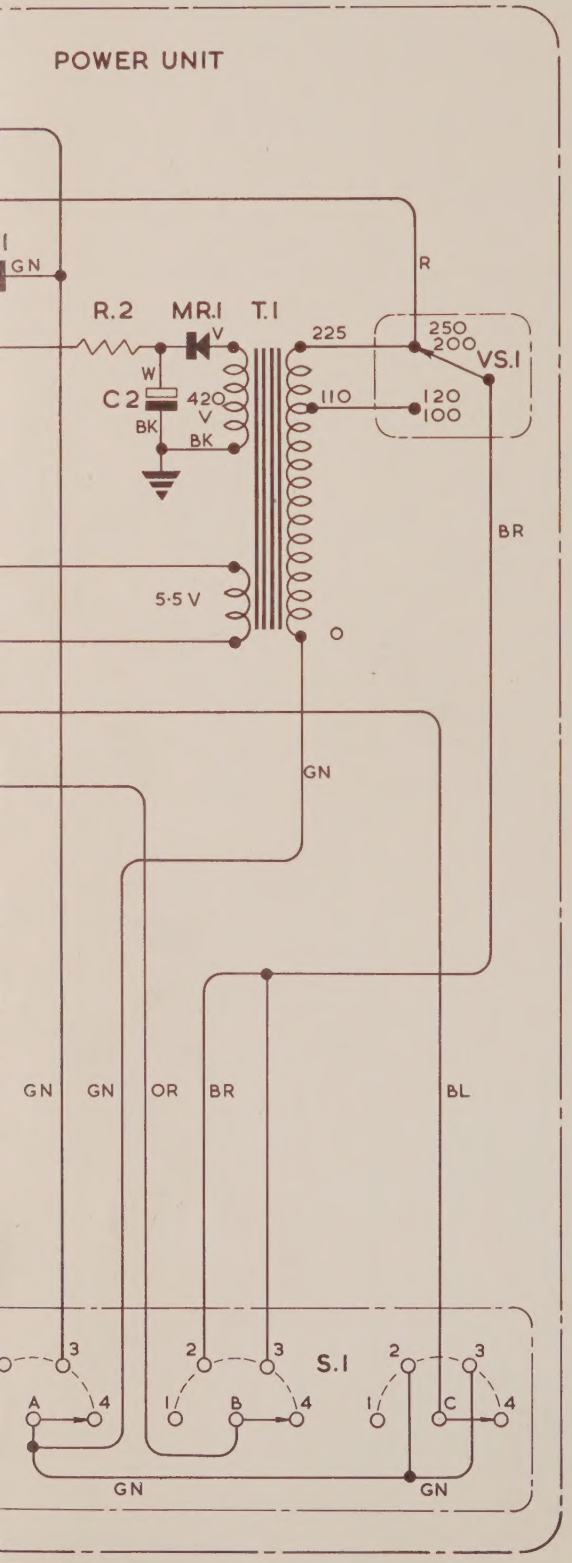
The moving coil is capable of dissipating 5 watts continuously in ambient temperatures up to 25°C.

REPLACEMENT SCHEME

A replacement and repair service is operated for all coil units.



CIRCUIT DIAGRAM



REF.	DESCRIPTION
VS.1	VOLTAGE SELECTOR, 2 WAY
MR1	RECTIFIER, SELENIUM. H.18 – 50 – I.R
LP.1	LAMP, INDICATOR BULB 6V. 3W
T.1	TRANSFORMER Nº 343
S.1	SWITCH WAFER, 3 POLE 4 WAY
M.1	MOTOR M 25 MK.I.
F.1	FUSE, 500m/A. GLASS CARTRIDGE.
F2	FUSE, 500m/A. GLASS CARTRIDGE.
R2	RESISTOR, 150 KΩ CARBON.
R1	RESISTOR 2·2 MΩ CARBON INSULATED
C.2	CONDENSER 8 M.F.D. ELECTROLYTIC.
C.1	CONDENSER ·75 M.F.D. PAPER DIELECTRIC

CODE	COLOUR	CODE	COLOUR
BK	BLACK	BL	BLUE
BR	BROWN	OR	ORANGE
R	RED	W	WHITE
GN	GREEN	V	VIOLET
GY	GREY	Y	YELLOW

Amendment Record

Amendments may be issued either as a complete reprint page for replacements or as a set of instructions enabling handwritten or other changes to be made to existing matter.

Replacement Page. The relevant page in the Manual should be removed and destroyed, and the replacement page inserted.

Handwritten or other changes. The instructions given in these amendment sheets should be carefully carried out.

AMENDMENT REFERENCE	INSERTED BY	AMENDMENT REFERENCE	INSERTED BY
See top outer corner of Amendment Sheet	*Initial or sign in this column only after Amendment has been carried out.*	*See top outer corner of Amendment Sheet*	*Initial or sign in this column only after Amendment has been carried out.*

www.manualsplus.com
1003539